

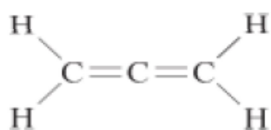
Suggested end-of-chapter problems for Ch. 9

Question numbers correspond to the 9th edition. The number in parentheses corresponds to the 10th edition (if the question is omitted in the 10th edition, a "--" appears in parentheses)

- 9 (11). In the hybrid orbital model, compare and contrast σ bonds with π bonds. What orbitals form the σ bonds and what orbitals form the π bonds? Assume the z -axis is the internuclear axis.
- 12 (14). The atoms in a single bond can rotate about the internuclear axis without breaking the bond. The atoms in a double and triple bond cannot rotate about the internuclear axis unless the bond is broken. Why?
- 14 (18). What modification to the molecular orbital model was made from the experimental evidence that B_2 is paramagnetic?
- 16 (20). The three NO bonds in NO_3^- are all equivalent in length and strength. How is this explained even though any valid Lewis structure for NO_3^- has one double bond and two single bonds to nitrogen?
- 29 (33). For each of the following molecules, write the Lewis structure(s), predict the molecular structure (including bond angles), give the expected hybrid orbitals on the central atom, and predict the overall polarity.
- CF_4
 - NF_3
 - OF_2
 - BF_3
 - BeH_2
 - TeF_4
 - AsF_5
 - KrF_2
 - KrF_4
 - SeF_6
 - IF_5
 - IF_3

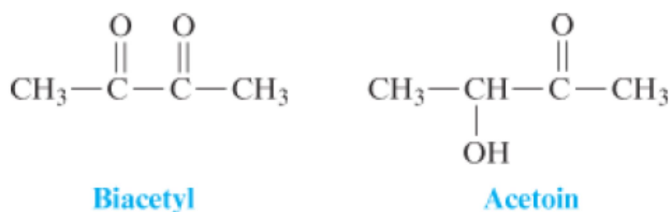
31 (35). Why must all six atoms in C_2H_4 lie in the same plane?

32 (36). The allene molecule has the following Lewis structure:



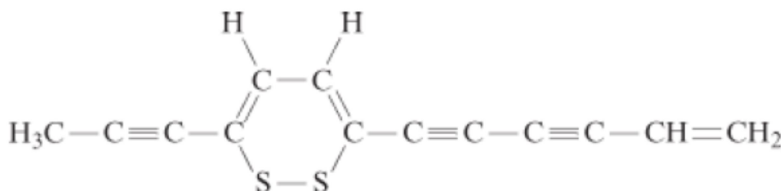
Must all hydrogen atoms lie the same plane? If not, what is their spatial relationship? Explain.

35 (39). Biacetyl and acetoin are added to margarine to make it taste more like butter.



Complete the Lewis structures, predict values for all $C-C-O$ bond angles, and give the hybridization of the carbon atoms in these two compounds. Must the four carbon atoms and two oxygen atoms in biacetyl lie the same plane? How many σ bonds and how many π bonds are there in biacetyl and acetoin?

40 (--). The antibiotic thiarubin-A was discovered by studying the feeding habits of wild chimpanzees in Tanzania. The structure for thiarubin-A is



a. Complete the Lewis structure showing all lone pairs of electrons.

b. Indicate the hybrid orbitals used by the carbon and sulfur atoms in thiarubin-A.

c. How many σ and π bonds are present in this molecule?

43 (47). Which of the following are predicted by the molecular orbital model to be stable diatomic species?

a. H_2^+ , H_2 , H_2^- , H_2^{2-}

b. He_2^{2+} , He_2^+ , He_2

44 (48). Which of the following are predicted by the molecular orbital model to be stable diatomic species?

a. N_2^{2-} , O_2^{2-} , F_2^{2-}

b. Be_2 , B_2 , Ne_2

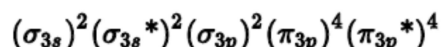
45 (49). Using the molecular orbital model, write electron configurations for the following diatomic species and calculate the bond orders. Which ones are paramagnetic?

a. Li_2

b. C_2

c. S_2

46 (50). Consider the following electron configuration:



Give four species that, in theory, would have this electron configuration.

47 (--). Using molecular orbital theory, explain why the removal of one electron in O_2 strengthens bonding, while the removal of one electron in N_2 weakens bonding.

48 (52). Using the molecular orbital model to describe the bonding in F_2^+ , F_2 , and F_2^- , predict the bond orders and the relative bond lengths for these three species. How many unpaired electrons are present in each species?

51 (55). Using the molecular orbital model, write electron configurations for the following diatomic species and calculate the bond orders. Which ones are paramagnetic? Place the species in order of increasing bond length and bond energy.

a. CO

b. CO^+

c. CO^{2+}

53 (57). In which of the following diatomic molecules would the bond strength be expected to weaken as an electron is removed?

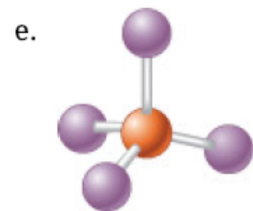
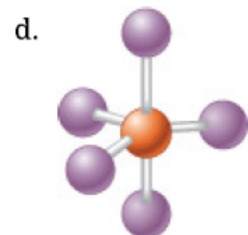
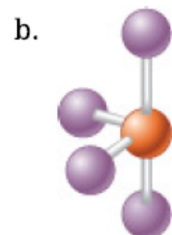
a. H_2

b. B_2

c. C_2^{2-}

d. OF

66 (70). Give the expected hybridization for the molecular structures illustrated below.



73 (77). The N_2O molecule is linear and polar.

- On the basis of this experimental evidence, which arrangement, NNO or NON , is correct? Explain your answer.
- On the basis of your answer to part a, write the Lewis structure of N_2O (including resonance forms). Give the formal charge on each atom and the hybridization of the central atom.
- How would the multiple bonding in $:\text{N}\equiv\text{N}-\ddot{\text{O}}:$ be described in terms of orbitals?